

THE GLOBAL THREAT REDUCTION INITIATIVE AND CONVERSION OF ISOTOPE PRODUCTION TO LEU TARGETS

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ABSTRACT

The U.S. Global Threat Reduction Initiative (GTRI) has given a decisive impetus to the RERTR program's longstanding goal of converting worldwide production of medical radioisotopes from reliance on bomb-grade, highly enriched uranium (HEU) to low-enriched uranium (LEU) unsuitable for weapons. Although the four major isotope producers continue to resist calls for conversion, they face mounting pressure from a variety of fronts including: (1) GTRI; (2) a related, multilateral U.S. initiative to forge agreement on conversion among the states that are home to the major producers; (3) an IAEA effort to provide technical assistance that will facilitate large-scale production of medical isotopes using LEU by producers who seek to do so; (4) planned production in the United States of substantial quantities of medical isotopes using LEU; and (5) pending U.S. legislation that would prohibit the export of HEU for production of isotopes as soon as alternative, LEU-produced isotopes are available. Accordingly, it now appears inevitable that worldwide isotope production will be converted from reliance on HEU to LEU. The only remaining question is which producers will be the first to reliably deliver sizeable quantities of LEU-produced isotopes and thereby capture global market share from the others.

1. Introduction

The advent of the U.S. Global Threat Reduction Initiative (GTRI) has given a decisive impetus to the longstanding goal of the RERTR program to convert worldwide production of medical radioisotopes from reliance on targets of bomb-grade, highly enriched uranium (HEU) to targets of low-enriched uranium (LEU), unsuitable for weapons. Although major isotope producers continue to resist calls for conversion, they face mounting pressure from a variety of fronts: (1) the GTRI, whereby the United States has established as a top foreign-policy priority the phasing out of remaining global civilian commerce in HEU; (2) a related, multilateral U.S. initiative to convene the states home to the world's four leading producers of medical isotopes, together with representatives of the producers themselves, to reach agreement on conversion from HEU to LEU; (3) an IAEA effort to provide technical assistance to new and emerging producers of medical isotopes, to ensure their production processes rely on LEU rather than HEU; (4) plans for a new production facility in the United States that would produce substantial quantities of medical isotopes using LEU rather than HEU; and (5) pending U.S. legislation that would prohibit the export of HEU for isotope production as soon as sufficient alternative LEU-produced isotopes are available. Accordingly, it now appears inevitable that

worldwide isotope production will be converted from reliance on HEU to LEU. The only remaining question is which producers will be the first to reliably deliver sizeable quantities of isotopes produced with LEU and thereby capture global market share from the others.

2. History of Efforts to Promote Conversion of Isotope Production

The RERTR program was created in 1978 to phase out international civilian commerce in HEU to reduce the risk of such material being diverted or stolen to make nuclear weapons. Initial efforts focused on reducing use of HEU as fuel in nuclear research and test reactors, which accounted for the bulk of civilian commerce. Toward this end, the program developed alternate reactor fuels of high-density LEU and assisted operators with conversion, an effort that has been highly successful and continues for Soviet-origin reactors and the few remaining western-origin reactors that have yet to convert [1]. As this effort rapidly succeeded in reducing commerce in HEU for fuel, the program expanded its attention to HEU used as targets for production of medical isotopes. HEU commerce for isotope production has been a growing proportion of total HEU commerce owing both to the declining use of such uranium as fuel and the increasing use of it to produce isotopes to satisfy a growing medical demand. Already, worldwide isotope production utilizes approximately 85 kilograms of HEU annually, approximately ten percent of total civilian HEU commerce [2].

For about 15 years, the RERTR program has worked to develop alternative LEU targets for medical isotope production. The task is complicated by the fact that most isotope producers have a unique target design. In addition, two opposite production processes are in commercial use, one relying on acid and the other on base dissolution. Despite these challenges, the program has now successfully developed targets and processes for production of medical isotopes using LEU targets relying on both acid and base dissolution. Argentina has successfully implemented a base dissolution process. Indonesia has successfully tested an acid dissolution process, although the final demonstration of the system was postponed because of the terrorist attacks of September 11, 2004 [1]. In addition, Australia uses LEU targets of its own design, employing 2.1%-enriched uranium to produce isotopes for its domestic market and neighboring states. The RERTR program is also working with Australia to improve the efficiency of this isotope production by converting to a 19.75%-enriched LEU target. Several prospective new isotope producers also have worked with the RERTR to facilitate start-up of production using LEU. For example, South Korea has a cooperative agreement with RERTR to focus on development of LEU targets and has withdrawn a previous request for HEU. Russia is also exploring production of isotopes using LEU in a liquid core reactor.

A 1992 U.S. law, the Schumer amendment to the Energy Policy Act, significantly increased the incentive for reactor operators and isotope producers to convert from HEU to LEU for both fuel and targets. With regard to the latter, the law explicitly prohibits exports of HEU for use as targets to produce medical isotopes unless all of three conditions are met: (1) no suitable LEU target has yet been developed, (2) the producer has pledged to convert as soon as a suitable LEU target is developed; and (3) the U.S. is actively developing a suitable LEU target. Thus, unless

reactor operators pledge to convert to LEU targets, cooperate in the development of such targets, and then convert when able, they risk losing access to HEU from the United States, which could halt their production of isotopes. Although the U.S. Nuclear Regulatory Commission (NRC) has yet to block an export of HEU for use as targets to produce medical isotopes, the Commission has repeatedly cited its intent to enforce the Schumer amendment.

Despite this additional incentive, the world's major isotope producers remain reluctant to convert, in part because they fear the potential expense of conversion could leave them at a competitive disadvantage relative to producers who refuse to convert. To address this problem, in 1999, the Nuclear Control Institute proposed that all producers sign a pledge to convert from reliance on HEU to LEU. The proposed pledge stated: "We, the undersigned current producers and planned producers of medical radio-isotopes . . . do hereby pledge – (1) To convert as quickly as possible from HEU to LEU targets for the production of medical radio-isotopes; and (2) To actively develop and/or cooperate in the development of specific LEU target designs and processes for our own production of medical isotopes, in order to enable such expeditious conversion." NCI contended that, "With such a level playing field, no producer would need fear being put at a competitive disadvantage by conversion" [3].

Initially, this proposal was embraced by the U.S. Department of State, the RERTR program, and several isotope producers, who slightly revised the pledge language and then signaled agreement in 2000. But the U.S. Department of Energy halted this initiative in 2001, arguing to NCI that, "even if the U.S. Government were successful in obtaining such a pledge from the commercial producers of Moly-99, it would not result in the goals you seek. Without the commitment of the governments involved to the conversion, the pledges of individuals from the producers will have little meaning. For the U.S. Government to go directly to the producing entities in these countries could also be seen by the other governments as meddling in their internal affairs. An approach that would have a better chance of success would be to call a meeting of the governments involved as a way of seeking a common policy in this area" [4]. As detailed below, the U.S. DOE has recently begun to pursue that alternative approach, somewhat belatedly.

3. Continuing Opposition from Major Isotope Producers

Four large producers currently dominate the worldwide market for medical isotopes: MDS Nordion in Canada; Mallinckrodt in the Netherlands; Institut National des Radioelements (IRE) in Belgium; and the Nuclear Energy Corporation of South Africa (NECSA). All four resist conversion. Moreover, two of them, Nordion and Mallinckrodt, have attempted to undermine the Schumer amendment in order to guarantee themselves U.S. exports of HEU.

Nordion claims to be the world's largest producer of medical isotopes. Historically, it has produced these isotopes at Canada's aging NRU reactor using targets fabricated of HEU exported from the United States. As early as 1990, the U.S. NRC expressed concerns about the danger posed by these continuing exports. Responding in December 1990, Atomic Energy Canada Limited (AECL) indicated its intention to build two new Maple reactors to produce isotopes and pledged to develop

a new LEU target by 1998 for use in them, so as to "phase out HEU use by 2000" [5]. However, AECL and its privatized counterpart Nordion reneged on this commitment, and instead designed their new Maple reactors and New Processing Facility to use HEU targets. U.S. officials, following enactment of the Schumer amendment, made clear to the Canadians that further HEU exports would not be permitted unless the Canadians actively engaged in a program to convert to LEU targets. Accordingly, in September 1997, when Nordion requested another export of HEU for the NRU, Canadian representatives also signed an exchange of notes, committing again to develop and convert to LEU targets – a commitment they have repeated several times since. In 1999, the U.S. NRC explicitly warned Nordion that if it violated the Schumer amendment by failing to cooperate towards converting as soon as possible, "the Commission may modify, suspend, or revoke the license" for export of HEU to produce isotopes at its Maple reactors [6].

Despite Nordion's repeated commitments and the NRC's explicit warning, Nordion initially cooperated only minimally with U.S. efforts to facilitate its conversion and then by September 2003 completely halted cooperation towards conversion [7]. At the time, Nordion contended that contrary to its previous assurances it could not convert its new processing facility to handle LEU targets without unacceptable interruption in the production of medical isotopes. Nordion declared it would not proceed with conversion unless provided funding to construct an entirely new processing line, estimated to cost \$90 million. On February 26, 2004, NCI alerted the U.S. government to this situation. On May 6, 2004, NRC and DOE officials called Nordion representatives to Washington and reminded them that the Schumer amendment required cooperation towards conversion as a precondition for exports of HEU. Nordion quickly responded, in its annual report to the NRC on May 19, 2004, that it was seeking "to resume discussions" with the U.S. government on conversion of its new processing facility [8]. Nordion also conceded in that report that the only remaining significant technical hurdle to converting to LEU targets is determining how to handle a larger volume and mass of waste, a challenge the RERTR program was addressing before Nordion suspended cooperation.

At the same time, however, Nordion joined forces with another large producer, Mallinckrodt, to lobby the U.S. Congress to eviscerate the Schumer amendment restrictions on exports of HEU for production of medical isotopes. They drafted an amendment, persuaded Rep. Richard Burr (R-NC) to sponsor it, and succeeded at having it incorporated into the energy bill approved by the U.S. House of Representatives in 2003-04. After the amendment drew critical attention in the press [9], however, it was not incorporated in the Senate version of the bill, despite the efforts of Sen. Christopher Bond (R-MO), who represents the home state of Mallinckrodt's corporate headquarters. A House-Senate conference version of the energy bill included a watered-down version of the amendment (discussed in greater detail below), but the overall bill died because of Senate opposition to many of its provisions.

In an additional effort to avoid conversion, Nordion earlier this year appealed in writing to the IAEA to endorse its continued reliance on HEU rather than conversion to LEU. The IAEA rebuffed Nordion's effort, however, instead telling the producer that the agency believed conversion to LEU was very important. Moreover, the IAEA told Nordion that as a large producer of medical isotopes it was well-

positioned to lead global efforts to convert isotope production from reliance on HEU to LEU [10].

4. Global Threat Reduction Initiative

The U.S. government recently increased dramatically its efforts to phase out worldwide HEU commerce. In a speech on May 26, 2004, here at the IAEA in Vienna, the U.S. Secretary of Energy launched a “Global Threat Reduction Initiative,” aimed at eliminating HEU commerce and securing existing stockpiles of high-risk nuclear materials. He announced, “I have instructed the National Nuclear Security Administration to work closely with the Department of State and other agencies to develop the diplomatic strategy necessary to secure, remove, or eliminate these materials.” On the same day, the U.S. Department of Energy made clear this policy applied to HEU for targets to produce medical isotopes: “This new initiative will build upon existing and long-standing U.S. nonproliferation efforts to minimize and eventually eliminate any reliance on HEU in the civilian fuel cycle, including conversion of research and test reactors worldwide from the use of HEU to the use of low-enriched uranium fuels and targets” [11]. In addition, a DOE fact sheet identified one of GTRI’s four top priorities as targeting “research reactors and medical isotope production processes worldwide for conversion to suitable LEU fuels and targets” [12].

5. Multilateral Initiative by the U.S. Department of Energy

As noted above, the U.S. Department of Energy is attempting to forge an agreement among the states that are home to the world’s four largest producers of medical isotopes, requiring these producers to convert as soon as possible from reliance on HEU to LEU. So far, the initiative has been delayed by scheduling difficulties and the internal DOE reorganization to implement the GTRI. An initial meeting of diplomats from the four states and the United States, along with representatives of the four producers in audience, was scheduled for June 2004 in Las Vegas, then rescheduled for Philadelphia, then rescheduled for Vienna last month, before being postponed again. The DOE now aims to hold the meeting in approximately March 2005. Despite such unfortunate delays, the U.S. official leading this effort within GTRI says that “conversion of isotope production is integral to RERTR,” declaring that the U.S. government will not relent in its efforts to ensure that all producers, including Nordion, convert to LEU [13].

6. IAEA Coordinated Research Project

Complementary to the U.S. initiatives, the IAEA is launching a multilateral effort to facilitate production of medical isotopes using LEU by existing and emerging producers. An initial consultancy meeting will be held at the IAEA on November 15-19, 2004, to “prepare a coordinated research project (CRP) on transfer and adaptation of LEU targets to produce” medical isotopes. The terms of reference for this initiative state that the IAEA’s role is “to disseminate a technique which advances international non-proliferation objectives.” The CRP has already been approved for 2006-09, but

the IAEA hopes to obtain funds to commence earlier, in 2005. The participants in the initial consultancy include three producers that already rely on LEU – in Australia, Argentina, and Indonesia – as well as representatives from the United States and the four major producers that still rely on HEU in Canada, Belgium, the Netherlands, and South Africa [14]. Emerging producers, such as in South Korea, likely also will be included in the CRP. The objective is “to transfer know-how in the area of ^{99}Mo production using LEU targets,” by establishing procedures and an experimental program for development of targets and processes to produce medical isotopes with high quality control. This initiative will facilitate large-scale production of medical isotopes using LEU by producers who seek to do so.

7. Planned U.S. Isotope Production

In a development with dramatic potential to shake-up the global isotope industry, a U.S. company, TCI Medical, has received public and private financing for its plan to produce medical isotopes in the United States relying on LEU. The company’s innovative idea is to produce isotopes in the LEU liquid cores of new reactors, rather than utilizing targets. Each reactor’s core would be drawn off approximately weekly to extract the isotopes in a column at a processing facility before being returned to the reactor. TCI is cooperating with scientists in Kurchatov, Russia, who already employ a similar reactor concept using a liquid HEU core and who have received a grant from the Initiatives for Proliferation Program (IPP) to convert to a liquid LEU core. TCI’s plan is to build two or three processing facilities and about five small modules each containing two 50 kw reactors, to avoid the requirement for forced cooling that would arise if they built a single, larger reactor. Together, these facilities are envisioned to meet the entire U.S. domestic demand for medical isotopes derived from ^{99}Mo . Production capacity would ramp up gradually if the company staggered the construction of the reactors [10].

The start of construction for this project is currently held up by financing issues. In addition to having received at least \$8 million in private funding (from sources such as Canadian uranium supplier, Cameco Corp), TCI has been pledged \$7 million in financing from the state of New Mexico for product development and equipment – of which \$2 million already has been received, and the next tranche of \$3 million is to follow ground-breaking. However, TCI still needs an additional \$5 million to construct a 20,000 square-foot building for its facilities. Its efforts to finance construction of this plant in Carlsbad have failed so far, apparently because the region is economically depressed, so banks are reluctant to risk funds on a building that would remain vacant if TCI’s project fell through. Accordingly, TCI is considering moving the project to Albuquerque, where it would be easier to lease or construct a building. But a recent press report also indicates the company may have found a national bank willing to support construction in Carlsbad. In the meantime, TCI plans to break into the isotope business by purchasing ^{99}Mo from another producer and processing it into pharmaceuticals at a small facility in Missouri [15].

While TCI’s plans in New Mexico remain temporarily in limbo, the company does not appear to face any insurmountable obstacles to eventual construction of its facility. Once ground is broken, the company’s president John Rice estimates that only two to three years will be required to complete construction and obtain FDA

approval for the isotopes. Such estimates may be optimistic. Still, it appears quite possible that TCI will be producing substantial quantities of medical isotopes in the United States using LEU before the end of the decade. As explained below, this could have dramatic consequences for other producers who continue to rely on HEU.

8. Pending U.S. Legislation Creates Preference for Isotopes Produced with LEU

As noted above, the Burr-Bond amendment, which was originally intended to eviscerate Schumer amendment restrictions on exports of HEU for isotope production, was watered down in the final House-Senate conference version of the energy bill that ultimately was blocked by the Senate earlier this year. Among the changes to the amendment was one of potentially great importance, requiring that the U.S. NRC halt all further exports of HEU for targets to produce isotopes as soon as a sufficient supply of LEU-produced isotopes are available. “At such time as commercial facilities that do not use highly enriched uranium are capable of meeting domestic requirements for medical isotopes . . . the Commission shall, by rule, terminate its review of [HEU] export license applications” [16].

This provision is noteworthy for several reasons. It was approved by key pro-nuclear Republican legislators on the relevant committees in both houses of Congress, indicating that a consensus now exists on Capitol Hill that HEU exports for isotope production should be terminated as soon as LEU-produced isotopes are available. This strongly suggests that Congress also believes that only LEU-produced isotopes should be used in the United States as soon as that becomes an option. Although other aspects of the revised Burr-Bond amendment remain objectionable to NCI and to Congressional advocates of nuclear nonproliferation, this provision is not controversial and thus is likely to remain in the energy bill when and if it is enacted – which appears probable given that the newly elected Congress will have a larger Republican majority in the Senate. Thus, ironically, an amendment originally drafted to pave the way for continued HEU exports for isotope production may have the unintended consequence of terminating them.

9. Conclusion: Conversion Appears Inevitable and First Movers Will Gain Advantage

Putting all these pieces together suggests it is inevitable that worldwide isotope production will be converted from reliance on HEU to LEU. Moreover, given the highly competitive nature of the isotope market and the premium that customers place on reliable supply once achieved, long-term market share is likely to shift to those producers that are first to reliably supply substantial quantities of LEU-produced isotopes.

The United States will probably accelerate this trend by enacting preferences for LEU-produced isotopes, including banning exports of HEU for isotope production when sufficient quantities of LEU-produced alternatives become available. Such alternatives are very likely to become available in the next few years through one or more routes. One possibility is that TCI will succeed at producing large quantities of isotopes using LEU in the United States. A second possibility is that the IAEA’s CRP

technology-transfer initiative will enable one or both producers that already use LEU targets, in Argentina or Australia, to expand its production significantly, or enable an emerging producer to do so. A third possibility is that the combination of the U.S. and IAEA initiatives will compel and facilitate the conversion of an existing large-scale isotope producer from reliance on HEU to LEU. In any case, once one producer successfully produces and reliably supplies large quantities of isotopes using LEU, the others will race to copy the example in order to preserve or expand their market share. Those who succeed at doing so quickly will thrive, while others will suffer economically. Indeed, as is typical in new markets with barriers to entry, isotope producers could find themselves divided into “the quick and the dead.”

Currently, the four large producers of medical isotopes are resisting conversion because they fear the costs could put them at a competitive disadvantage and thereby sacrifice market share. This outlook is remarkably short-sighted from a business perspective. In the long-term, the economic reality will be exactly opposite. Whichever producer is first to reliably supply substantial quantities of LEU-produced isotopes will dominate the worldwide market. The only question is whether any of the existing large producers will figure that out before another producer does so and steals their market share.

References

- [1] Dr. Armando Travelli, “Fuel Issues: Replacement of HEU,” presentation to IAEA Scientific Forum, September 22, 2004.
- [2] U.S. Government Accountability Office, “Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors,” GAO-04-807, July 2004.
- [3] Alan J. Kuperman, “A Level Playing Field for Medical Isotope Production – How to Phase Out Reliance on Highly Enriched Uranium,” 22nd Annual International Meeting on Reduced Enrichment for Research and Test Reactors, Budapest, Hungary, October 7, 1999.
- [4] Trisha Dedik, U.S. Department of Energy, email to author, October 1, 2001.
- [5] J.B. Slater, General Manager, Major Facilities Business Centre Operations, AECL Research, “The Program on Future HEU Supply for AECL’s Radioisotope Production Operation,” December 4, 1990, submitted in support of XSNM-02667.
- [6] U.S. NRC, Memorandum and Order, CLI-99-20, June 29, 1999.
- [7] Alan J. Kuperman and Paul L. Leventhal, NCI, letter to Chairman Nils J. Diaz, NRC, February 26, 2004.
- [8] G.R. Malkoske, MDS Nordion, “Maple Reactors and New Processing Facility,” Yearly Status Report for the U.S. NRC on the Progress of the

Program and Canadian Cooperation in Developing LEU Targets for the Maple Reactors and the New Processing Facility, May 19, 2004.

- [9] R. Jeffrey Smith, "Measure Would Alter Nuclear Nonproliferation Policy: Energy Bill Provision Backed by Two Firms Would Ease Constraints on Exports of Bomb-Grade Uranium," *Washington Post*, October 4, 2003, p. A2. Alan J. Kuperman, "Loose Nukes of the West," *Washington Post*, op-ed, May 7, 2003. Alan J. Kuperman, "Running Risks with Uranium," *The News & Observer* (Raleigh, NC), op-ed, November 21, 2003.
- [10] Confidential personal communications with author.
- [11] U.S. Department of Energy, "Department of Energy Launches New Global Threat Reduction Initiative; Will accelerate and expand the security and removal of proliferation-sensitive materials," Vienna, Austria, May 26, 2004.
- [12] "Global Threat Reduction Initiative Highlights," available at http://www.usun-vienna.usia.co.at/Statements/Global_Threat_Reduction_Initiative_Highlights.html.
- [13] Kasia Mendelsohn, personal communication with author, October 29, 2004.
- [14] International Atomic Energy Agency, "Terms of Reference: Consultancy to Prepare a CRP on Transfer and Adaptation of LEU targets to Produce 99Mo Through Fission, VIC, 15-19 November 2004, C-0751."
- [15] Andrew Webb, "New Mexico's Investment May Put Nuclear Medicine Plant in Carlsbad," *Albuquerque Journal*, April 1, 2004. Andrew Webb, "Financing May Drive Firm to Build Nuclear-Medicine Plant in Albuquerque," *Albuquerque Journal*, September 21, 2004. Andrew Webb, "Bank May Back Carlsbad Plant," *Albuquerque Journal*, September 25, 2004. Andrew Webb, "New Mexico Officials Look to Expand High-Tech Development, Financing," *Albuquerque Journal*, October 14, 2004.
- [16] Conference Report on Energy Bill, U.S. Congress, November 14, 2003.